DEPARTMENT OF BIOLOGICAL SCIENCES
SEMINAR SERIES

Sean Quinn
Biochemistry & Biophysics Graduate Student

“Unraveling the Catalytic Properties of KIF3A and KIF3C in Heterodimeric KIF3AC”

Jane Thibeault
Biochemistry & Biophysics Graduate Student

“Hyperstable Protein Expression in Bacterial Pathogens”

Monday, March 26, 2018
12:00 Noon
CBIS, Bruggeman Room

REFRESHMENTS SERVED 11:45
Controlling Polymer Morphology through the Primary Structure

Polymers are ubiquitous in modern society. They make up everything from plastic bags and bottles to fuel cell membranes and photovoltaics. The macroscopic properties of all polymers, regardless of their ultimate use or chemical composition, are governed by their morphology. The morphology of a polymer is the overall form of the polymer structure. In other words, this is how the polymer chains interact with each other. Morphology can be influenced by many factors such as molecular weight, branching, crosslinking, and more. Given the prevalence of polymers in the world, surprisingly little is known about the morphology of even common polymers. In the Simocko Research Group we study polymer morphology and self-assembly in two research thrusts: 1) the synthesis of precise homo- and block polymers and 2) the synthesis and self-assembly of mixed polymer brushes. In this lecture, I will discuss the development of new monomers that undergo selective acyclic diene metathesis (SADMET) and how polymers created from these monomers will help us study the morphology of block polymer systems. I will also be discussing mixed polymer brushes and how we can control their self-assembly to create nanostructures and ongoing work of studying their thermal stability.

BIO: Dr. Chester Simocko began his undergraduate degree at RPI in 2004 where he did research under Dr. James Moore, studying polymers made from green feedstock, and Dr. Steven Cramer where he synthesized fluorescent displacers for displacement chromatography. He graduated in 2008 with a B.S. in Chemistry. He then went on to graduate school at the University of Florida where he studied precision polymers containing boronic acids under Dr. Ken Wagener. He received a Ph.D in Chemistry in 2013. After graduate school Dr. Simocko moved to Albuquerque, NM to take a post-doctoral position at Sandia National Laboratories in the Center for Integrated Nanotechnologies. While there he worked on many projects but the bulk of his work focused on the self-assembly of mixed polymer brushes. In the summer of 2016 he began his appointment as an Assistant Professor of Chemistry at San Jose State University. His research at SJSU focuses on the synthesis of precise block polymers as well as mixed polymer brushes. Currently the Simocko Research Group consists of 13 undergraduate students and 2 graduate students.
“Estimation and Fault Diagnostics of PDE Battery Electrochemistry Models”

Scott Moura
Assistant Professor | Director of eCAL
University of California, Berkeley

Wednesday, March 28, 2018
10:30 AM – 11:30 AM
DCC 330

Abstract:

Batteries are ubiquitous. However, today’s batteries are expensive, range-limited, power-restricted, die too quickly, charge too slowly, and susceptible to safety issues. For this reason, model-based battery management systems (BMS) are of extreme interest. In this talk, we discuss eCAL’s recent research electrochemical-based BMS, which are modeled by nonlinear partial differential equations (PDEs). Specifically, we discuss (i) state and parameter estimation, and (iii) fault diagnostics. Finally, we close with exciting new perspectives for next-generation battery systems.

BIO

Scott Moura is an Assistant Professor at the University of California, Berkeley in Civil Environmental Engineering and Director of eCAL. He received the Ph.D. degree from University of Michigan in 2011, the M.S. degree from the University of Michigan in 2008, and the B.S. degree from the UC Berkeley, in 2006 - all in Mechanical Engineering. He was a postdoctoral scholar at UC San Diego in the Cymer Center for Control Systems and Dynamics, and a visiting researcher in the Centre Automatique et Systèmes at MINES ParisTech in Paris, France. He is a recipient of the O. Hugo Shuck Best Paper Award, Carol D. Soc Distinguished Graduate Student Mentoring Award, Hellman Faculty Fellows Award, UC Presidential Postdoctoral Fellowship, National Science Foundation Graduate Research Fellowship, University of Michigan Distinguished ProQuest Dissertation Honorable Mention, University of Michigan Rackham Merit Fellowship, and Distinguished Leadership Award. He has received multiple conference best paper awards, as an advisor & student. His research interests include control & estimation theory for PDEs, optimization, machine learning, batteries, electric vehicles, and the smart grid.
ABSTRACT
Development of ultrafast electron and X-ray scattering methods has enabled direct routes to elucidating atomic-scale structural dynamics. Currently, the most wide-spread approaches involve using table-top, laser-driven electron-scattering chambers or X-ray free-electron lasers to probe dynamics in reciprocal space and over specimen regions that are large relative to unit-cell dimensions and discrete defects. As a result, the transients (typically some aspect of a Bragg reflection) are generated from a range of responses occurring within the probed region, and the influence of defects and impurities on local dynamics are not resolved. In this talk, I will show how such effects can be directly probed with ultrafast electron microscopy (UEM). After a brief overview of the operating principles of UEM, I will discuss how we are using femtosecond (fs) real-space imaging to directly visualize coherent structural dynamics in nanostructured and nanoscale materials. Specifically, I will describe the results of our studies of photoinduced acoustic-phonon dynamics in: (i) transition metal dichalcogenides (TMDs; MoS$_2$ and WSe$_2$), (ii) clusters of Au nanorods, and (iii) thin Ge crystals. In TMDs, we have found that fs photoexcitation leads to the generation of coherent phonon wavetrains at vacuum-crystal interfaces and extended crystal terraces. Correlative ultrafast parallel-beam diffraction studies, supplemented with finite-element modeling, indicate this occurs via an initial impulsive expansion along the c-axis stacking direction (i.e., via an interlayer expansion) followed by launch of in-plane phonon wavefronts propagating at the speed of sound (e.g., 5 nm/ps). In Au nanorods, we have directly imaged the generation of vibrational hot-spots at discrete rod-rod contact
points in randomly-oriented few-particle clusters, while coherent oscillations arising from excitation of a discrete acoustic-phonon mode are observed in isolated particles. For the final portion of the talk, I will discuss our most-recent results on the direct imaging of coherent, hypersonic (e.g., up to 35 nm/ps) acoustic-phonon dynamics in thin Ge crystals, including delayed generation of the wavetrains (~100 ps following photoexcitation) and a time-varying phase-velocity relaxation to the bulk speed of sound. I will conclude by comparing the observed structural dynamics in Ge to behaviors of hypersonic plasma waves in strongly-photoexcited semiconducting materials.

BIO
David Flannigan is currently an Assistant Professor of Chemical Engineering and Materials Science at the University of Minnesota, and he was recently appointed as the Director of Undergraduate Studies for Materials Science and Engineering. He received his B.S. and Ph.D. in Chemistry from the University of Minnesota and the University of Illinois at Urbana-Champaign, respectively. At Illinois, he studied the physical conditions and chemical processes associated with sonoluminescence under the guidance of Prof. Ken Suslick, for which he was awarded the T. S. Piper Award for Outstanding Thesis Research. After receiving his Ph.D., he was a Postdoctoral Scholar at the California Institute of Technology, where he worked on the development and application of ultrafast electron microscopy in the labs of Prof. Ahmed Zewail. He joined the faculty at Minnesota in 2012, where his research focuses on the study of materials dynamics with ultrafast electron imaging, diffraction, and spectroscopy. His group’s work in this area has been recognized with a Beckman Young Investigator Award, an NSF CAREER Award, and a DOE Early Career Award.
“Topological Phases of Quantum Matter as Novel Platforms for Fundamental Science and Applications”

I will discuss how topological phases arise in quantum matter through spin-orbit coupling effects in the presence of protections provided by time-reversal, crystalline and particle-hole symmetries, and highlight our recent work aimed at predicting new classes of topological insulators (TIs), topological crystalline insulators, Weyl semi-metals, and quantum spin Hall insulators. [1-7] Surfaces of three-dimensional (3D) topological materials and edges of two-dimensional (2D) topological materials support novel electronic states. For example, the surface of a 3D TI supports gapless or metallic states, which are robust against disorder and non-magnetic impurities, and in which the directions of momentum and spin are locked with each other. Similarly, in 2D TIs, also called quantum spin Hall insulators, the 1D topological edge states are not allowed to scatter since the only available backscattering channel is forbidden by constraints of time-reversal symmetry. The special symmetry protected electronic states in topological materials hold the exciting promise of providing revolutionary new platforms for exploring fundamental science questions, including novel spin textures and exotic superconductors, and for the realization of multifunctional topological devices for thermoelectric, spintronics, information processing and other applications. Work supported by the U. S. Department of Energy.

Bansil is a University Distinguished Professor in physics at Northeastern University (NU). He served at the US Department of Energy managing the flagship Theoretical Condensed Matter Physics program (2008-10). He is an academic editor of the international Journal of Physics and Chemistry of Solids (1994-), the founding director of NU’s Advanced Scientific Computation Center (1999-), and serves on various international editorial boards and commissions. He has authored/co-authored over 370 technical articles and 18 volumes of conference proceedings covering a wide range of topics in theoretical condensed matter and materials physics, and a major book on X-Ray Compton Scattering (Oxford University Press, Oxford, 2004). Bansil is a 2017 Highly Cited Researcher (Web of Science/Clarivate Analytics).
Center for Lighting Enabled Systems & Applications Seminar Series

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Thursday, March 29, 2018
2 pm – 3 pm
CBIS Isermann Auditorium

Exploring the effects of visible light on human sleep and circadian rhythms: Lab to daily life

Dr. Shadab Rahman
Instructor in Medicine
Harvard Medical School

Abstract:
Visible light induces a wide range of physiological responses in humans from altering gene expression to affecting mood. Technological advances have decreased the cost of producing artificial light and increased the luminous efficacy of luminaires. As a result, we have steadily increased our per capita light consumption, and can create our own light-dark schedules, independent of the natural day-night cycle. Exposure to artificial light in the evening and at night delays our endogenous biological clock impairing
nighttime sleep and daytime alertness. Insufficient sleep and biological clock misalignment is associated with various health disorders ranging from depression to diabetes. The growing adoption of energy-efficient solid-state lighting (SSL) technology presents itself as both the problem and a solution to light-exposure induced sleep and biological rhythm disruption. Short-wavelength light, which is typically high in SSL luminaires, induces maximal biological response to light thereby exacerbating the disruptive effects of artificial light exposure in the evening and at night.

Simultaneously, SSL technology allows superior capability of controlling lighting characteristics such as intensity and spectrum, which can be used to develop intelligent lighting solutions to minimize the detrimental effects, and maximize the beneficial effects of artificial light exposure. The current talk will briefly review our basic-science understanding of the physiological impacts of light exposure on human sleep and circadian rhythms, present findings from recent studies conducted in laboratories demonstrating the effects of artificial light exposure in the evening on human sleep and circadian rhythms, and explore the application of “big data” approaches in characterizing the efficacy of lighting interventions in daily life.

Bio:

Shadab Rahman, Ph.D., M.P.H. completed both undergraduate and graduate training at the University of Toronto, and postdoctoral training at Harvard Medical School. He currently serves as an Instructor in Medicine at Harvard Medical School and an Associate Neuroscientist at Brigham and Women’s hospitals respectively. His primary research interest is in basic and applied circadian photobiology with the goal to develop effective photobiologic countermeasures for circadian disruption.
Flexor tendon injuries in zone II of the hand are prone to debilitating adhesions, a form of scar tissue that obstructs gliding of the flexor tendons, severely impairing hand function. There are presently no pharmacologic treatments for the prevention or resolution of tendon adhesions, which still occur in as high as 30% of flexor tendon repairs, despite advances in surgical techniques and post-operative rehabilitation. We have previously reported that disruption of canonical TGF-β1 signaling in Smad3 knockout mice reduced flexor tendon adhesions but at the same time reduced the tensile strength of the repair tissue. Subsequently, we investigated downstream signaling mediators of fibrosis, and demonstrated that TGF-β1 upregulates the protease-suppressor, plasminogen activator inhibitor 1 (PAI-1), which suppresses the activation of proteases such as plasmin and matrix metalloproteases (MMP). Furthermore, we demonstrated in vitro that PAI-1 loss-of-function nullifies TGF-β1 inhibition of protease (plasmin and MMP) activity, without affecting cell proliferation. Indeed, PAI-1 appears to be elevated in clinical tendon adhesions samples. Further, examining flexor tendon healing in Serpine1 Knockout mice further demonstrated that PAI-1 loss-of-function reduces adhesions. Thus, we identified PAI-1 as a potential druggable target for enhancing flexor tendon remodeling and the mitigation of adhesions. To that end, we recently demonstrated the efficacy of an innovative nanoparticle-mediated siRNA delivery system to abrogate PAI-1 effects in zone II flexor tendon injuries in mice. Finally, we present new insights gained from RNA-seq experiments to better elucidate the mechanisms of fibrotic adhesions and identify new biologic pathways and therapeutic targets.
publications, 5 book chapters, and more than 150 conference papers and proceedings. He received several honors including the Kappa Delta Award in 2007 from the Orthopaedic Research Society and the American Academy of Orthopaedic Surgeons for his work on Functional Tissue Engineering for Tendon Repair. He has recently been inducted into the American Institute of Medical and Biological Engineers College of Fellows for his contributions to the field of Tissue Engineering. He is a member of the Editorial Review Boards of PloS One, the Journal of Orthopaedic Research, and the Journal of Bone and Mineral Research. In addition, he is a standing member of the Skeletal Biology Structure and Regeneration Study Section of the Center for Scientific Review at the National Institutes of Health. His research focuses primarily on Musculoskeletal Tissue Engineering with an emphasis on challenging clinical problems and translational solutions, using in vivo and in vitro models of tissue repair and clinically translatable outcome measures to assess the efficacy of repair.